INSTITUTE OF GEOPHYSICS
OF THE CZECH ACADEMY OF SCIENCES

Experience with the AASN data downloading, implementation of additional data quality control and application of a new arrival-time picker

Luděk Vecsey

Zurich, 29 August 2018

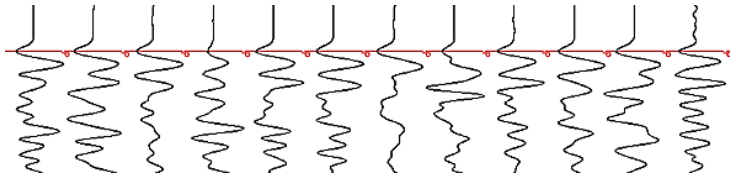
Fully automatic P-arrival time picker

list of teleseismic events

station metadata

seismic signals (mseeds)

arrival-time picker



Earthquake event list

```
obspy.clients.fdsn.Client("IRIS").get_events()
```

IRIS DMC FDSNWS event Web Service

- catalog sources: ISC, NEIC PDE

Notice This web service will not be offered long term.
[http://service.iris.edu/fdsnws/event/1/]

original event list: Oct 2017

updated event list: Jul 2018

⇒ 5 high-quality events are missing in the updated list of 2018 from IRIS!

but they are included in ISC catalog

Origin time	lat	long	depth	magn	dist	baz	region
14/08/19 21:32:17.6	32.71	47.57	13	5.4mb	30.4	110.3	IRAN-IRAQ BORDER REGION (ISC/ISC)
14/08/23 20:05:18.96	32.67	47.78	17	5.4mb	30.6	110.1	IRAN-IRAQ BORDER REGION (ISC/ISC)
15/02/06 08:52:28.8	38.81	15.00	246	4.7mb	10.8	172.2	SICILY, ITALY (ISC/ISC)
15/05/09 08:22:41.7	38.68	15.29	210	4.7mb	10.9	171.3	SICILY, ITALY (ISC/ISC)
15/08/29 20:25:13.5	38.50	12.11	8	4.6mb	11.0	184.4	SICILY, ITALY (ISC/ISC)

Station metadata

```
obspy.clients.fdsn.Client("[EIDA]").get_stations()
```

Mistakes in metadata:

- **TH.ZEITZ** – mistake in **longitude** by 0.6°
- **GR.GE??** – different **channel names** in metadata (EH) and mseeds (SH)
- **IV.FVI, NI.POLC, NI.VINO, RF.GEPF** – Guralp **poles & zeros** in Hz instead of rad/s (in a stage A = Laplace transform analog response, in rad/sec)
- **PL.GKP, PL.KSP** – missing **decimation stage** in DIGITAL (Z-TRANSFORM):

  ObsPy will crash during reading such metadata!

```
<Stage number="8">
    <PolesZeros name="GFZ:PL1980:MK6_iirpaz_1" resourceId="ResponsePAZ#20140204183351.059033.32">
        <InputUnits><Name>COUNTS</Name></InputUnits>
        <OutputUnits><Name>COUNTS</Name></OutputUnits>
        <PzTransferFunctionType>DIGITAL (Z-TRANSFORM)</PzTransferFunctionType>
         …
    </PolesZeros>
    <Decimation>
        <InputSampleRate unit="HERTZ">100.0</InputSampleRate>
        <Factor>1</Factor><Offset>0</Offset><Delay>0.0</Delay><Correction>0.0</Correction>
    </Decimation>
```

MISSING!

Downloading seismic data from EIDA

ArcLink

user protected access to AASN data

automatic routing

(default)

permanent AA-EASI (XT) AASN (Z3)

no routing

`get_waveforms(route=False)`

A038A, A144A, A145A, A146A, A147B, A148B

(the stations data migrated from BGR node to LMU)

FDSN

no routing

(but you can use FDSN routing web services first)

~~permanent stations in ODC~~ (e.g., CR, OE, SL)

solved

ArcLink ODC **host name** has been **changed** from eida.knmi.nl to eida.orfeus-eu.org

Problematic stations A038A, A144A, A145A, A146A, A147B, A148B

What we found:

- mseeds can be downloaded only by ArcLink in **no-routing mode** directly from LMU node
- stations are **not included** in the ODC **WebDC3** web interface
- stations are **not listed** in the ODC **Station Book**

Missing A140A .. A146A

Missing A147B, A148B

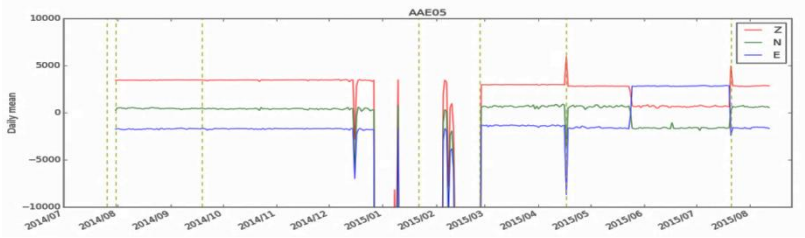
ODC Station Book

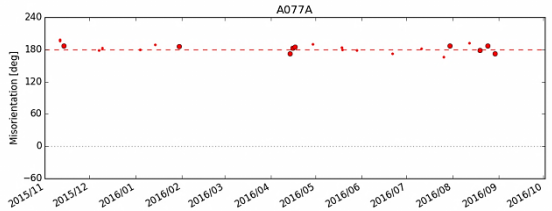
Z3	**A127A**	49.1967 N	7.9781 E	442	Yes	Yes
Z3	**A128A**	49.3986 N	8.5963 E	104	Yes	Yes
Z3	**A129A**	49.3426 N	7.7420 E	364	Yes	Yes
Z3	**A147A**	48.5379 N	12.9455 E	389	No	Yes
Z3	**A148A**	48.4780 N	12.4605 E	492	No	Yes
Z3	**A151A**	48.8820 N	6.3798 E	214	Yes	Yes
Z3	**A152A**	48.7248 N	6.8539 E	279	Yes	Yes

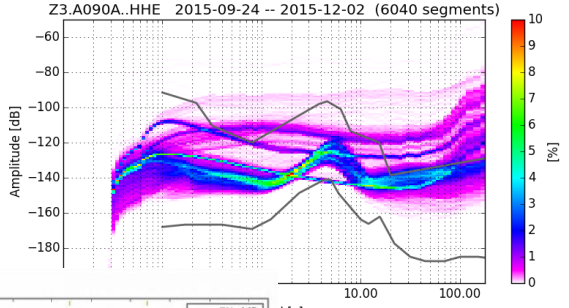
Is this issue connected to metadata access? Maybe similar to the Arclink Inventory synchronization problem of INGV data (solved in April 2018 by P. Danecek)?

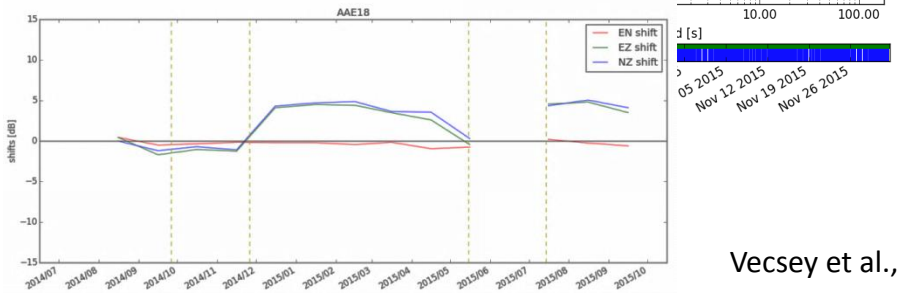
Data quality check

- Interchange of components, reversed channel polarity
- Timing issues: leap second, switch between UTC and GPS times, loss of time synchronization, malfunction of an oscillator tuning the station time
- Sensor mis-orientation
- Amplitude gain imperfection
- Seismic noise

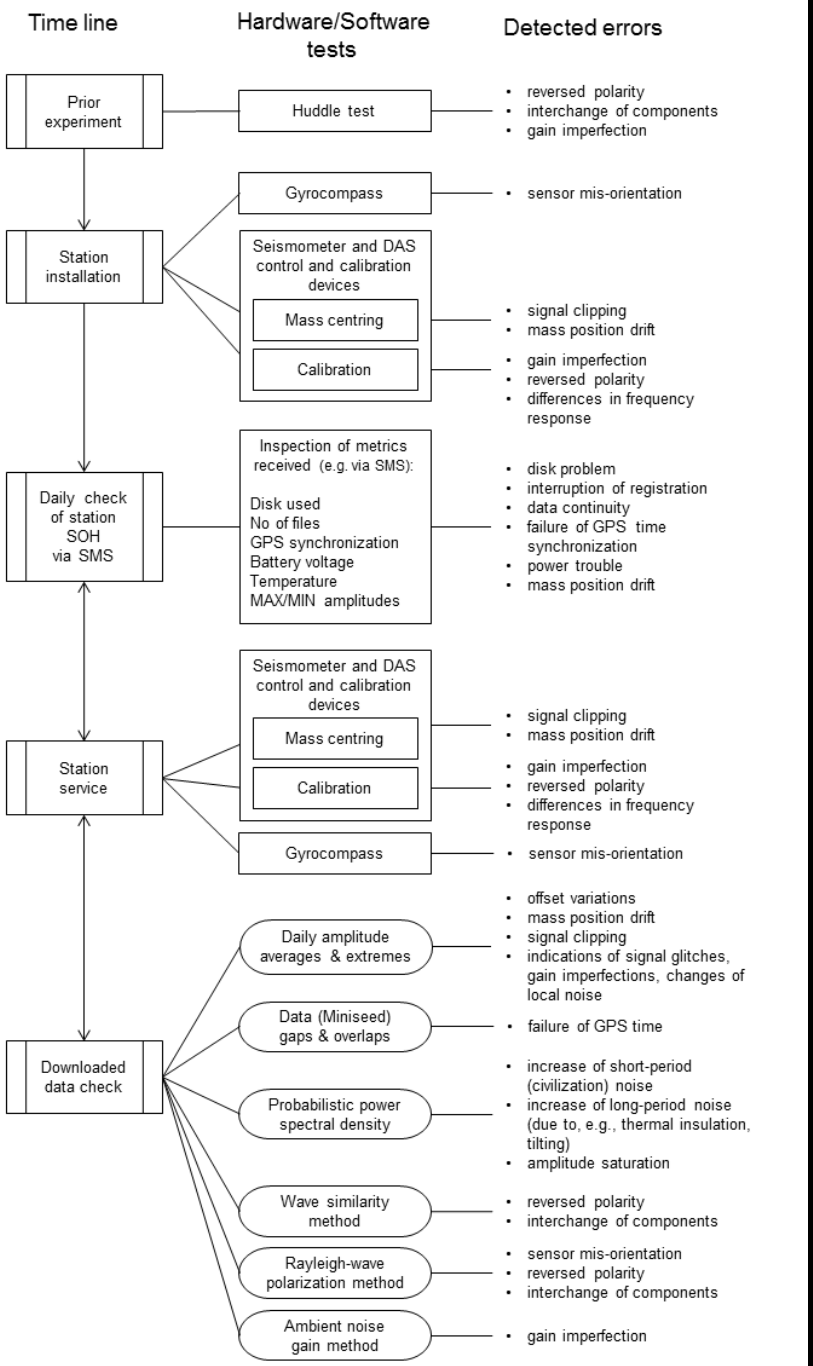








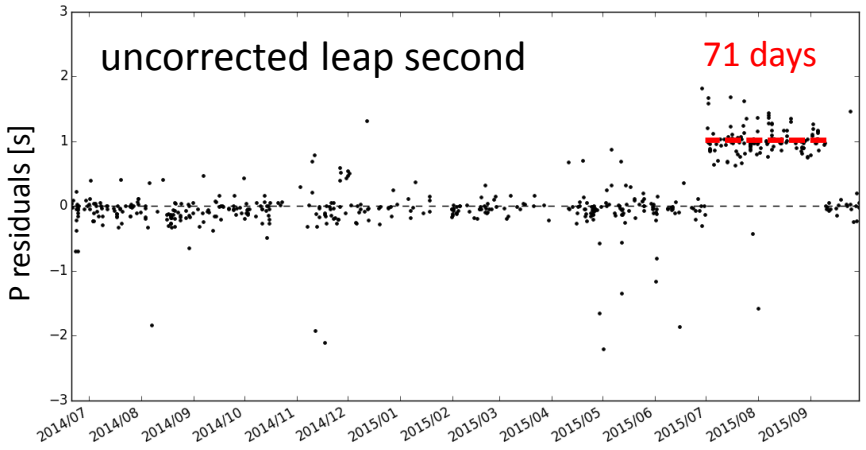
Vecsey et al., 2017



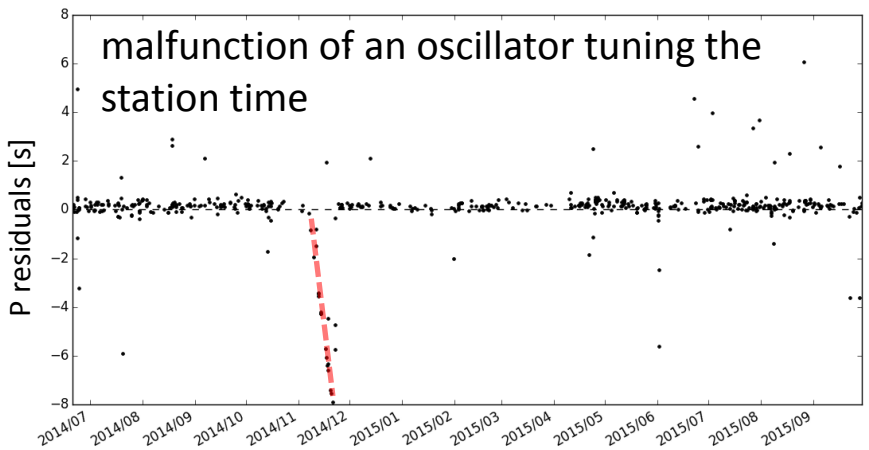
Vecsey et al., 2017

Time instabilities - examples

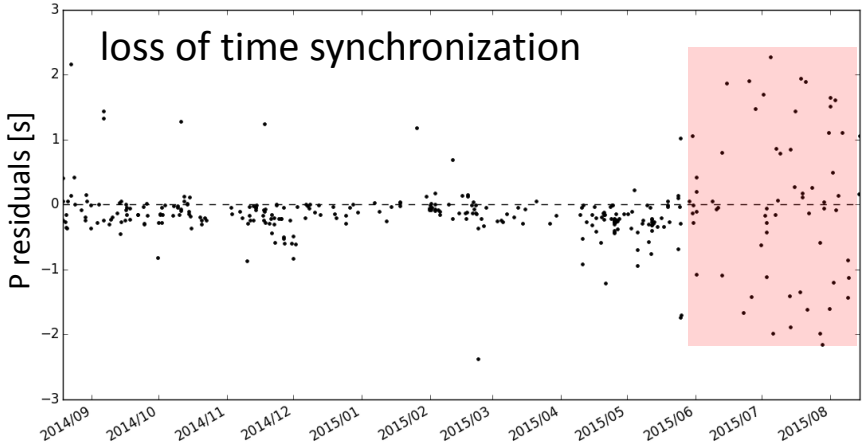
TH.HKWD..HHZ



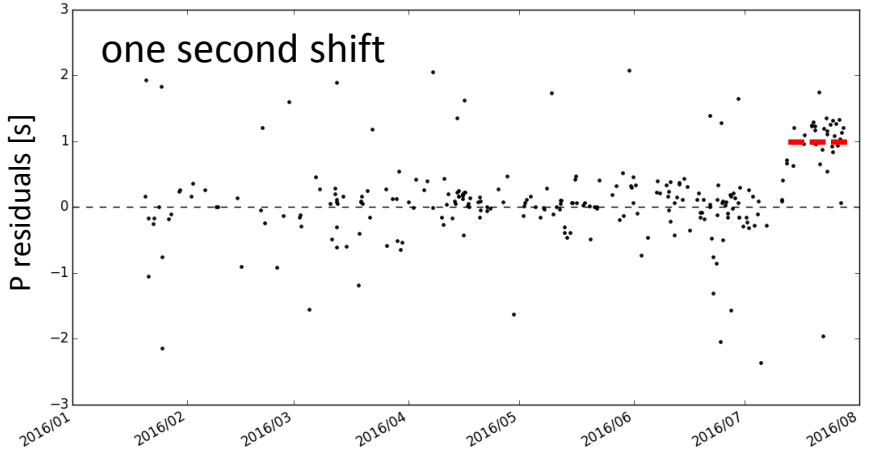
BW.MGBB..EHZ



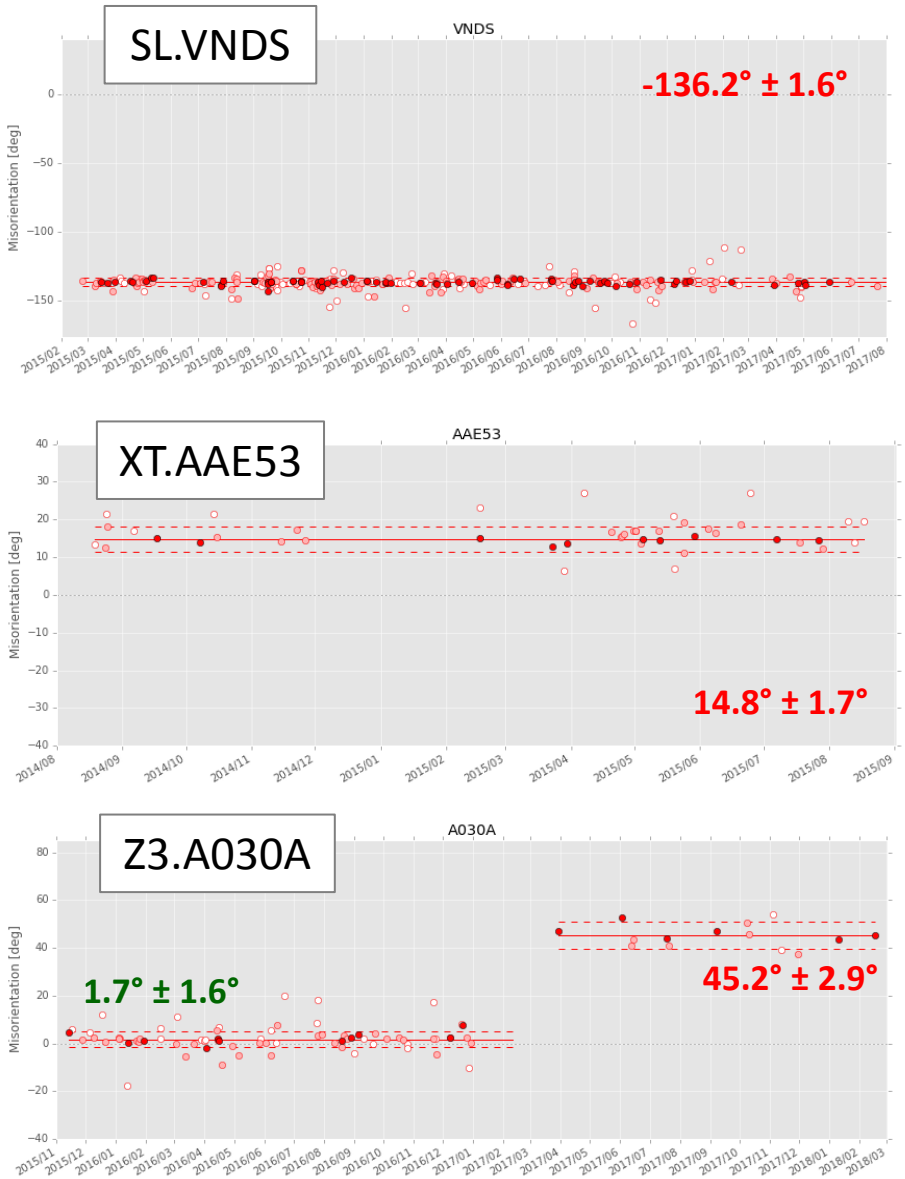
XT.AAE21..HHZ

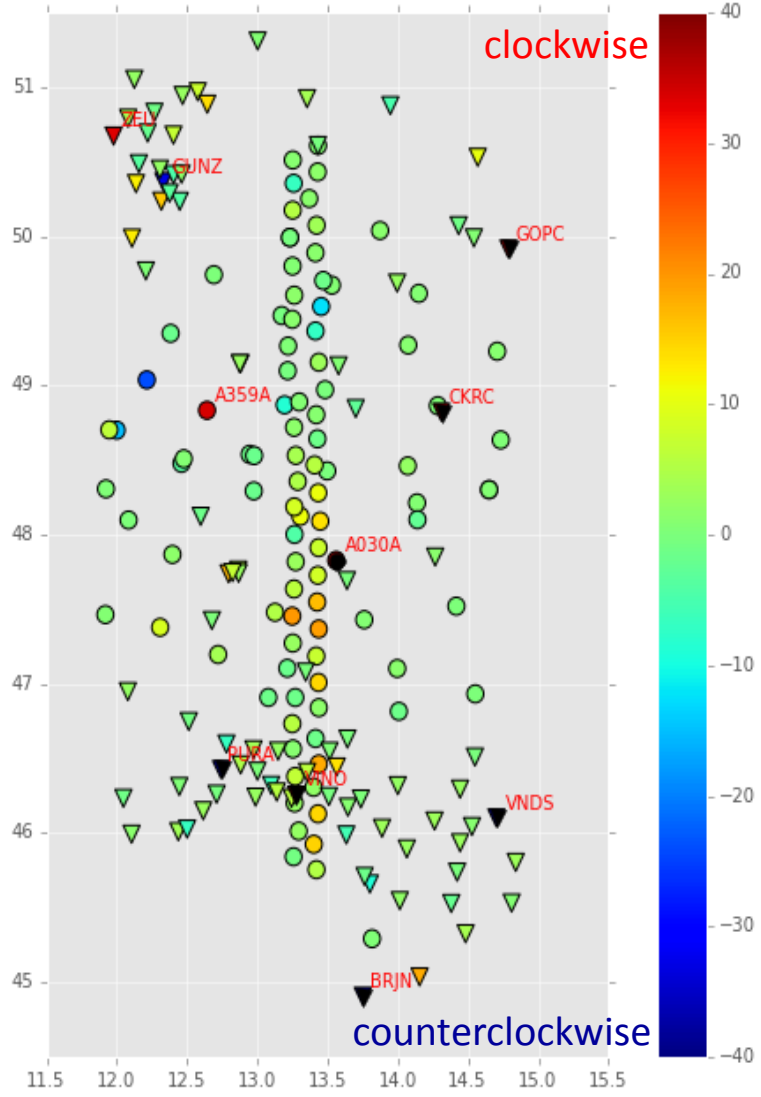


Z3.A147A.00.HHZ



Sensor mis-orientations





Mis-orientations colored from **blue** (-40°) to **red** (+40°), larger deviations are in **black**. Stations with their mis-orientations exceeding 30° are named. Triangles mark permanent stations, circles temporary ones.

Vecsey et al., EGU2018-9415

EIDAWS WFCatalog waveform metadata webservice

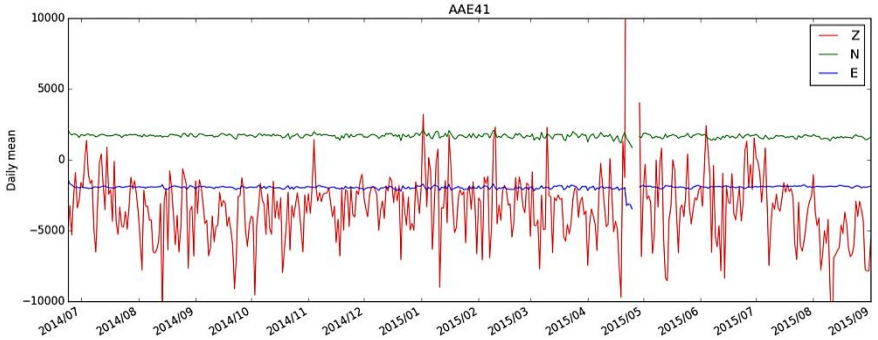
- provides detailed information on the contents of waveform data including quality control parameters

Applications:

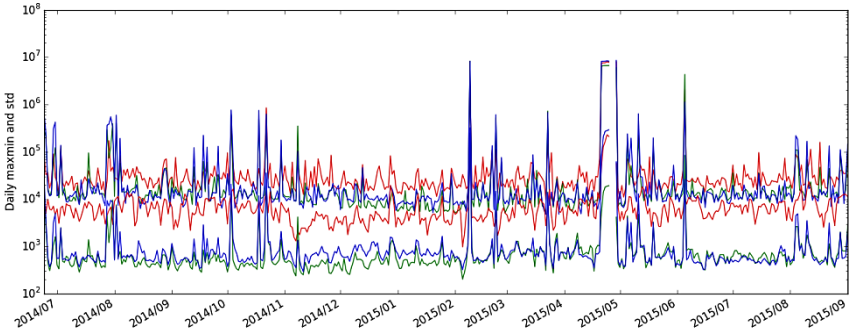
- check of **correct names of channels** and **components** in station metadata
- help in determination of which signal data are **available to download** from EIDA
- metrics showing station **state of health**

XT.AAE41

daily means



daily max-min and std

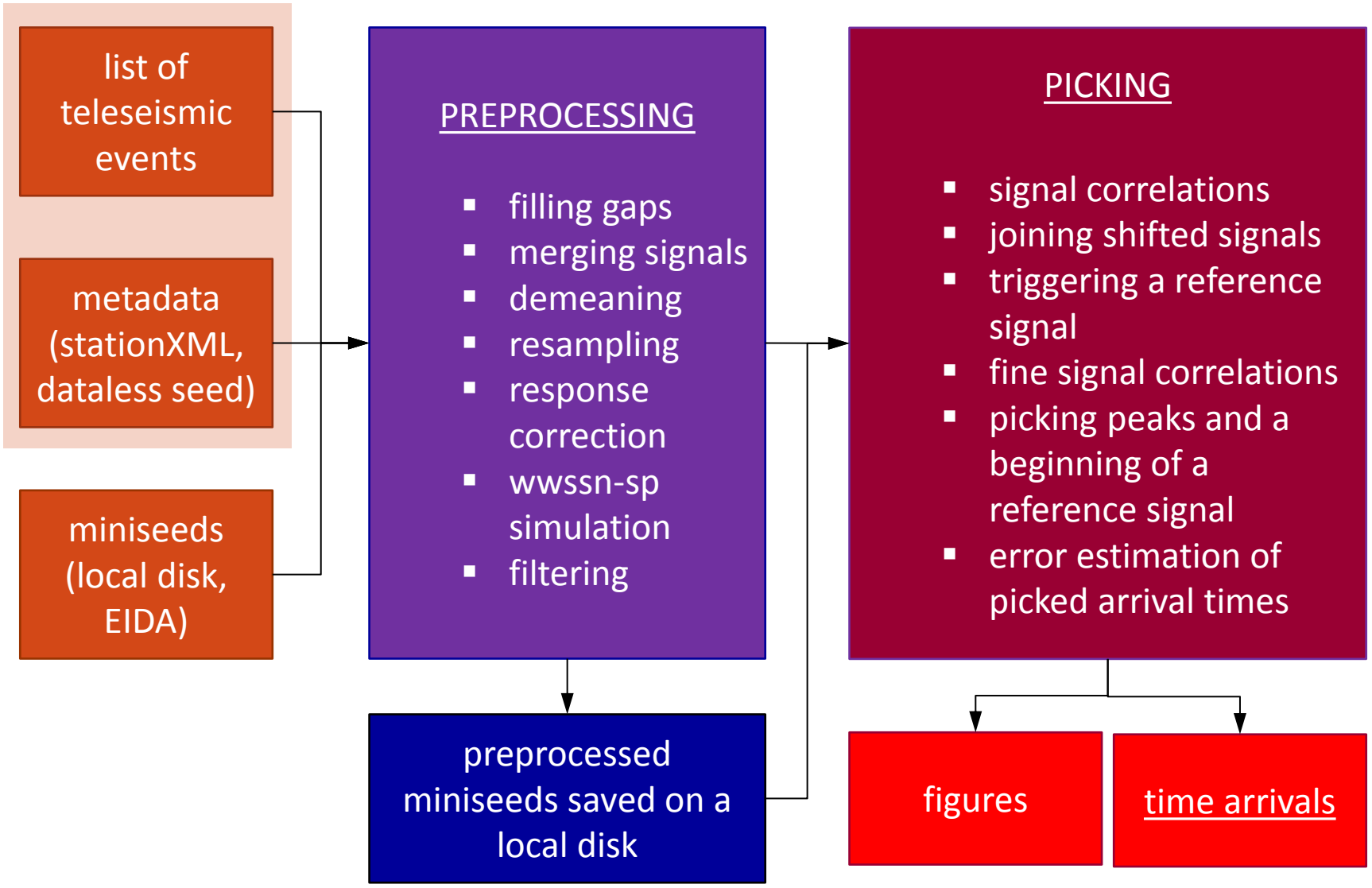


TimePicker 2017

- Fully automatic picker of teleseismic P arrivals
- Method based on (two-step) **signal correlations**
- **Relative picks** of extremes (peaks) are recomputed to absolute picks by signal comparison to a reference signal
- **Error estimates** determined by levels of SNRs and signal similarities
- Platform: ObsPy/Python

- First implementation:
  AlpArray-EASI project, area with 235 broadband and short-period stations, ~1800 events, 250 000 picks

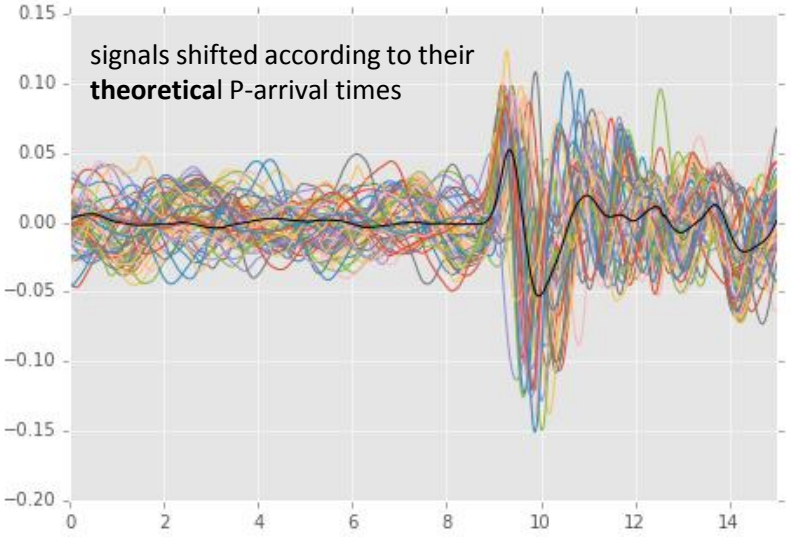
TimePicker flowchart

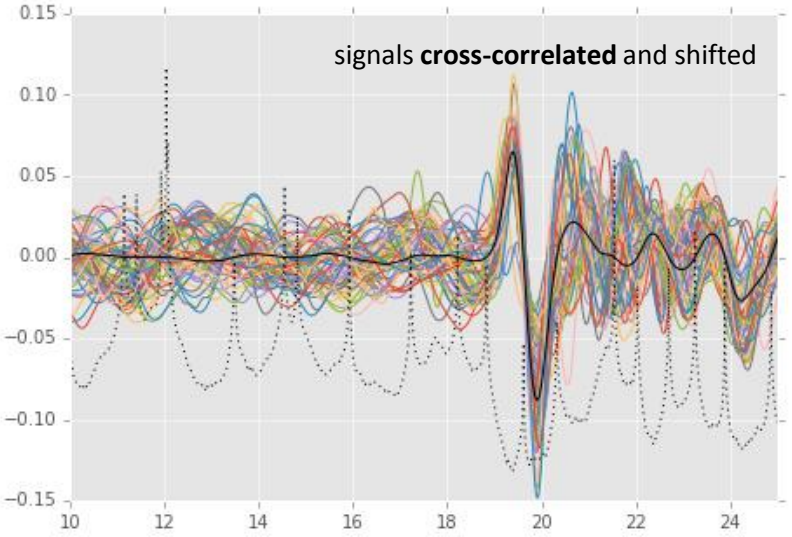


14/06/20 22:54:19.5 29.87 50.90 10 5.0mb 34.5 110.4 SOUTHERN IRAN (NEIC)

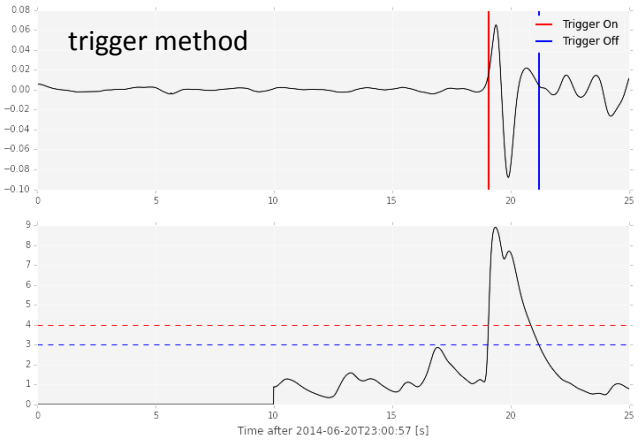
Reference signal

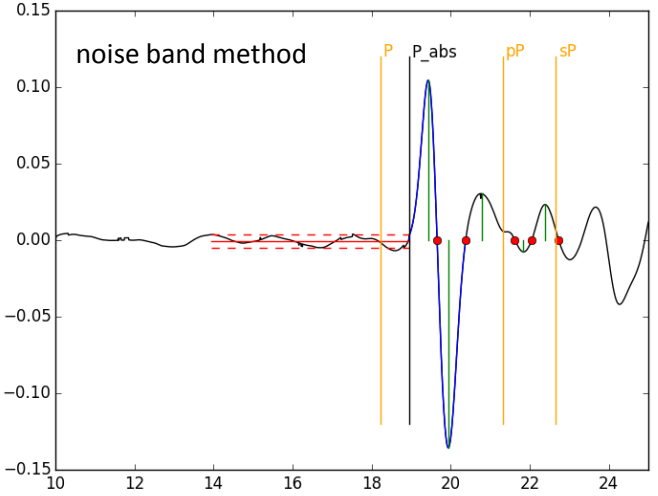
Summation of correlated signals



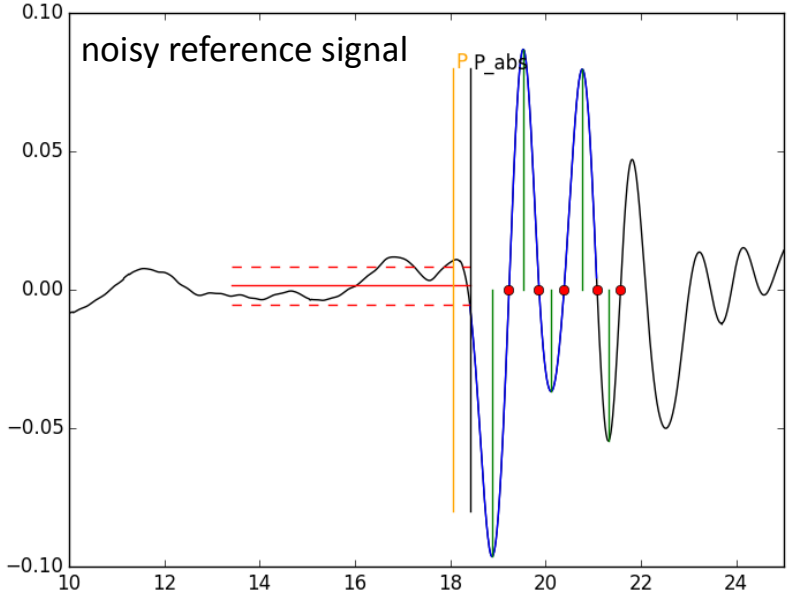


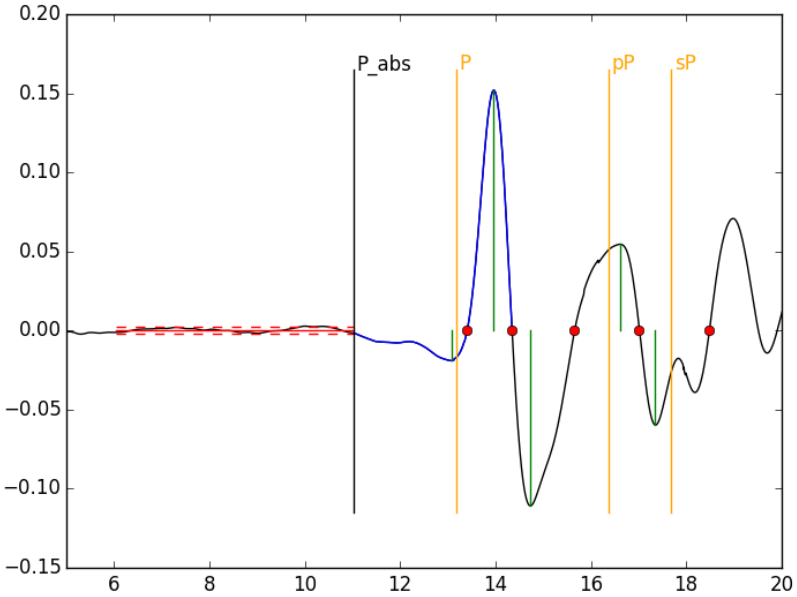
Picking a beginning of the reference signal

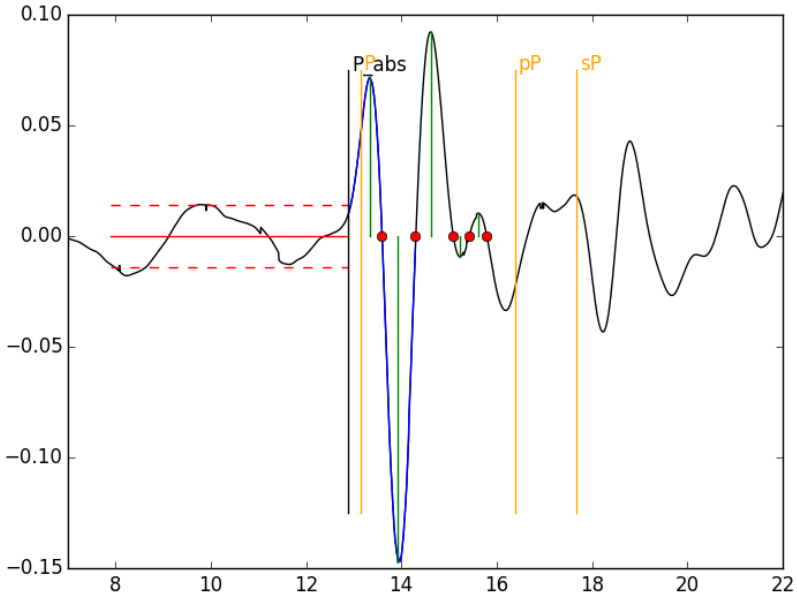


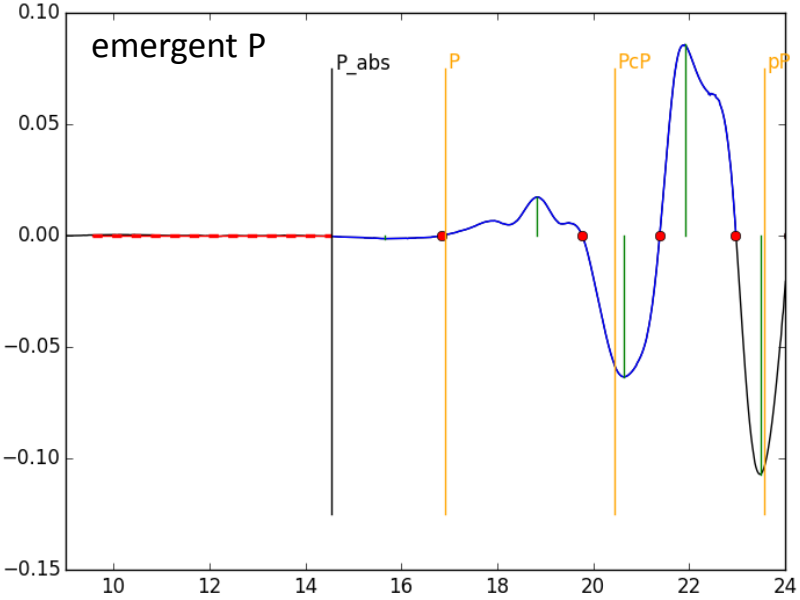


Reference signal - examples



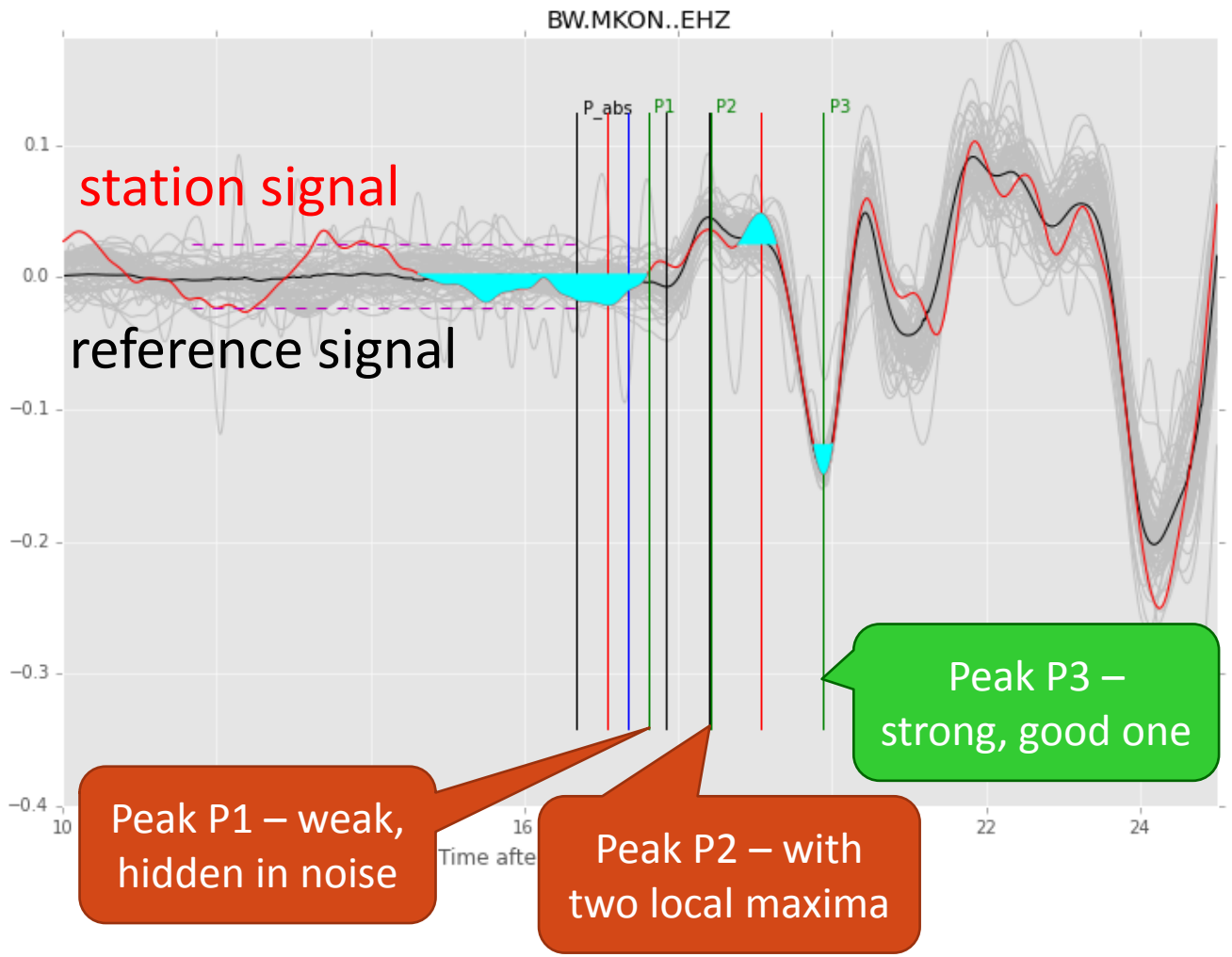






Picking peak times and error estimates

Main principle: relative time of a peak as close to a wave beginning as possible but with high SNR



For each station:

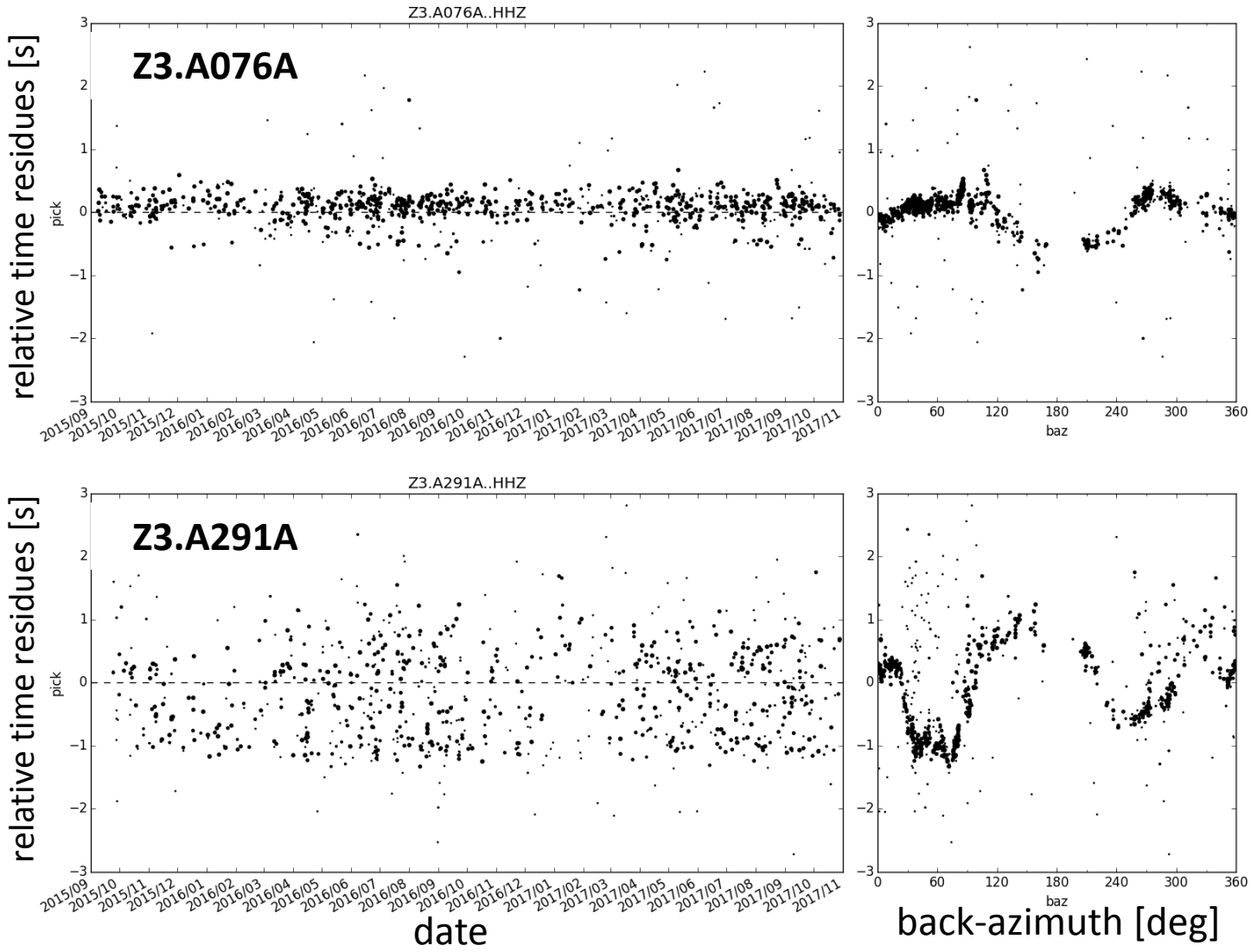
- max/min pick
- global correlation pick
- local correlation pick

Time of a final pick is a combination of these three picks.

Error estimate:

- SNR
- similarity of the signal to the reference signal
- distance between the peak and the P-arrival time P_abs.

First application of the code - AlpArray-EASI



Conclusions

- Modules of ObsPy/Python together with easy connection to integrated data archives (EIDA, IRIS) clear the way for **fully automated procedures** for seismic data analysis
- **Quality check** of input data (events, station metadata, signals) **is necessary** during all steps of automatic procedures
- The hardware control in-situ and the ex-post software data checking represent the **double check** of data quality. We have developed both **special control devices** for seismometers and GAIA DAS, and **methods and software codes** to identify and correct problems in data
- New code TimePicker 2017 is a fully automated software for picking teleseismic P-arrivals by a relative **cross-correlation** method. The code estimates **picking errors** defined by levels of SNRs and signal similarities.